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Increasing true shallot seed bulbs weight through manure application

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ABSTRACT

The Government has made efforts to increase shallot production through the use of shallot seeds. The problem is, information about the technology components of shallot cultivation from seeds is still limited. This research aimed to get the right dose of manure to increase the weight of shallot bulbs in seeds. The research was conducted in West Sumatra, Indonesia. Randomized Completely Block Design (RCBD) with 6 treatments of cow dung (0 t/ha, 5 t/ha, 10 t/ha, 15 t/ha, 20 t/ha, and 25 t/ha) each with 4 replications. Manure dose treatment had a significant effect on plant height, number of leaves per clump, number of tillers per bulb, bulb diameter, wet biomass weight, and dry bulb weight. A significant positive correlation was obtained between the manure dose and all components of the observation, except bulb shrinkage. Other than that, the addition of manure as much as 1,000 kg/ha, can increase the weight of wet biomass by 524.1 kg/ha and the weight of dry bulbs by 293.4 kg/ha. Cultivation of shallots using seeds is profitable when using manure of more than 5 t/ha, identified by RCR> 1. The results of this study suggest increasing the yield of shallot bulbs from seeds by using cow dung as much as 10-25 t/ha. Facilitation of shallot seeds (TSS) from the Government is needed so that farmers have easy access to seeds to develop shallots in the future.

Keywords: True Shallot Seed, seed bulbs, manure application

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1. Introduction

Shallots (*Allium ascalonicum* L) is one of the horticultural commodities in Indonesia. The planting of these commodities is spread throughout the province, except in the province of Riau Islands. Regional production centers for shallot are located in Central Java, East Java, West Nusa Tenggara, West Java, South Sulawesi, and West Sumatra. Also, the area of shallot harvesting has always increased from year to year, namely 120,704 ha, 122,126 ha, 149,635 ha, and 158,172 ha. On the contrary, the productivity has decreased fromyear to year namely 10,22 t/ha, 10,06 t/ha, 9,67 t/ha, dan 9,29 t/ha in 2014, 2015, 2016, dan 2017 [1]. The problem is that the increase in planting shallots also increases the need for seed bulbs. According to [2], there are restrictions on the supply of quality seed from bulbs, among others: (1) it requires an extensive collection of seed from bulbs; (2) it requires seed from giantbulbs; (3) it involves storage because of large quantities and dormancy; (4) the age of use of seed from short bulbs, the quality of the seed will decrease after four months and will be damaged. The need for seed bulbs per ha is 1.2 – 2 tonnes[2, 3], and the use of seed bulbsis more expensive especially when the seed bulbs stock is limited [4]. If the average use is assumed to be 1.5 t/ha at IDR 30,000/kg, it will require as many as 181,056 tonnes, 183,189 tonnes, 224,453 tonnes, and 237,258 tonnes, at purchase costs of Rp 5.4 trillion, IDR 5.5 trillion, IDR 6.7 trillion, and IDR 7.1 trillion, respectively, were required in 2014, 2015, 2016, and 2017. In addition to the depletion of funds due to the purchase of seeds from giant bulbs (IDR 45 million/ha), a large yield (about 10-15% of the crop) to meet the needs of seed origin of bulbs during the next season is a threat to the success of the shallot self-sufficiency program, particularly in the provision of shallots for the consumption of Indonesian people. Based on the above, the Ministry of Agriculture since the 1990s has begun to develop technology to cultivate shallots from seeds (TSS = True Shallot Seed) [5, 6]. They started using seed from seed to produce mini bulbs which can reduce the need for seeds by almost half (750 kg of mini bulbs/ha). Furthermore, shallot cultivation is developed for consumption using seeds from seeds which have advantages, among others: (1) can be stored for more than one year; (2) free of fungi, bacteria, nematodes, insects, and rarely contaminated by viruses and seed-borne diseases; (3) the cost of seeds is relatively cheap (Rp. 15 million/ha); (4) flexible, can be planted when needed; (5) bulbs shape and size are relatively more uniform; and (6) higher productivity, reaching>20 t/ha [7, 8]. One component of the technology that can increase the productivity of seed shallot plants is manure. Manure can increase soil fertility by improving physical, chemical, and biological soil properties, including topsoil, growing populations of microorganisms and enhancing water absorption and storage capacity, and effectively reduce soil evaporation[9]. The addition of manure increases the content of organic matter in the soil and increases the content of N, P, and K elements so that it can help the growth process and increase crop yields[10, 11]. Previous studies have shown that shallot production in dryland increased by adding bokashi compost and NPK fertilizer[12-14]. The manure application of 15-25 t/ha significantly affected bulbs shallots plants [15]. In the meantime, there has been little research on the effect of manure on seeds from shallot plants. This study aims to obtain the correct dose of manure by increasing the yield of shallots bulbs from seeds.

2. Material and methods

The study was conducted from August to December 2019 at Sukarami Experimental Station, Assessment Institute for Agricultural Technology, West Sumatra, Solok Regency, West Sumatra Province, Indonesia, at about 900 m above sea level (asl) and Andosol soil types. The results of the soil analysis before the study were: pH H_2O (5.4), pH KCl (4.97), C-organic (4.22%), N Kjeldahl (0.48%), P_2O_5 Bray I (19.7 ppm), K-dd (1.14 Cmol/kg), and C/N 8.79. While the results of the analysis of the manure nutrient content are: pH H_2O (8.94), C-organic (22.56%), N (1.77%), P (0.15%), K (0.35%), and C/N (12.75), Ca (0.94%), Mg (0.16%%) and Na (0.13%). The study was arranged using Randomized Completelly Block Design (RCBD) with six doses of manure treatment and four replications for each treatment with up to 24 units. The doses of cow manure are: P0 = 0 t/ha, P1 = 5 t/ha, P2 = 10 t/ha, P3 = 15 t/ha, P4 = 20 t/ha, and P5 = 25 t/ha. The implementation of the research begins with preparing seeds from shallot seeds, seedling, planting, maintaining plants, and harvesting, as follows: (1) The shallot seeds of the Trisula variety originating from the Lembang Vegetable Research Institute, West Java are first soaked for + 24 hours to speed up the process of seed germination; (2) Prepare a nursery medium in the form of a mixture of fine soil and manure with a ratio of 1: 1 (soil: manure) which is put into a plastic tray, then the seedling media is watered until it is saturated with water, then the seedling is carried out in rows with a distance between rows around 5 cm; (3) Maintenance of seedling by watering if the seedling medium is dry, while pest/disease control is carried out if damage is found due to pest/disease attacks; (4) Preparation of the land by means of hoeing 30-40 cm deep until loose, then making beds with the size of 100 cm wide, 7 m long, 25-30 cm high, and the distance between the beds 30 cm; (5) Lime as much as 2 t/ha, essential fertilizer NPK Phonska (15-15-15) as much as 600 kg/ha, and manure according to the treatment is given spread out on the bed, then incubated for 2 weeks by covering the beds using plastic mulch black silver; (6) Planting is done by transplanting the seeds that have been sown for 5 weeks to a planting hole with a spacing of 20x20 cm, 2 seeds per planting hole; (7) Fertilizer supplement (150 kg/ha NPK Phonska) is given with a cast system, starting at the age of 4 weeks after planting (WAP) with an interval of 1x2 weeks, 3 times. The trick is to dissolve the fertilizer in water (10-20 g/l), then pour it into the planting hole (100-200 ml per plant); (8) Weeding is carried out based on the growing conditions of weeds in the planting area, by removing weeds by hand around the planting hole and using a hoe/sickle between the beds; (9) Pest/disease control by giving Curator 3G at planting in the planting hole, followed by spraying insecticide/fungicide 2x1 week; (10) Irrigation is carried out when the beds dry out by watering or irrigating the beds with an overflow system; and (11) Harvesting is done when the leaves start to turn yellow (80%), the top of the plant begins to fall, the base of the leaves is flat, most of the bulbs are sticking up above the ground, there has been a distinctive red pigment formation, and the appearance of dark red or red purplish on bulbs. Harvesting is done by pulling the plants carefully, then collecting and drying (using indirect sunlight). Observations were made on growth components (plant height and number of leaves per clump) 75 days after planting (DAP), yield components (number of tillers per bulbs and bulbs diameter) 75 DAP, bulbs weight (wet and dry) and shrink bulbs. Wet bulbs weight was observed when the shallots crop was harvested, while dry bulbs weight was observed after one week of drying. Observed data, then tabulated and performed variance analysis (F test) and, if a real difference is found, further testing is performed using DMRT (Duncan Multiple Range Test) at a 5 percent level [16, 17]. The economic analysis used the methodology of [18]to assessing and calculating the expenditures and economic profit of different cow manure treatments.

$$Net\ \pi = TR - TC$$

Net profit is the total revenue subtracted from the total cost. Total Revenue (TR) per acre earned from the sale of strawberries was calculated by multiplying the farmer's price received per mound with the total output produced (mound) in the season. Production cost per hectare (TC) was the expense of farmers to buy seeds, fertilizers, pesticides, nursery costs, and labor wages. Then Revenue Cost Ratio (RCR) was estimated by dividing total revenue with total cost:

$$RCR = TR/TC$$

The value of RCR must be greater than the production cost to benefits farmers [19].

3. Results and discussion

3.1. Growth components

The growth components observed were the height of the plant and the number of leaves per cluster. The results showed that manure's dose significantly affected plant height and number of leaves per clumps of shallots seedlings (Table 1). It can be seen that the increase in plant height due to the supply of manure ranges from 7.16 to 21.23 percent. The highest plants with a dose of 25 t/ha (47.4 cm) of manure were significantly different from those with a 0 t/ha (39.1 cm) of manure. In the meantime, the addition of the number of leaves per clumps due to the supply of manure ranged from 22.95 to 137.47. The highest number of leaves was found when manure was administered at a dose of 25 t/ha (50.70 strands), significantly different from manure administered at a dose of 0 t/ha (21.35 strands) and a dose of 5 t/ha (26.25 strands). Correlation analysis results show that the higher the dose of manure given, the higher the plant and the more leaves per clumps, with the same coefficient of correlation (r), r = 0.95. The addition of a dose of manure will improve the soil's physical properties and add macro and micronutrients to the soil, significantly increasing the total N-value of soil and C-organic soil and soil C uptake, and negatively correlated with pH [20, 21].

Table 1. Effect of manure dose on plant height and the number of leaves per clump of shallots plants from seed. Sukarami Experimental Station, Planting Season, 2019

Treatment Manure (t/ha)	Growth components	
	Plant height (cm)	Number of Leaves per Clump
0	39.1 b	21.35 b
5	41.9 ab	26.25 b
10	43.0 ab	41.55 a
15	46.0 ab	42.60 a
20	44.8 ab	45.55 a
25	47.4 a	50.70 a

Note. The numbers followed by different letters indicate the significant difference at the 0.05 DMRT level

Table 1 also shows that manure significantly affected plant height compared with no manure at a dose of 25 t/ha, while on the number of leaves per clump at 10 t/ha. Lasmini et al.[22] reported that giving rice straw mulch and cow manure as much as 5 t/ha is the best for increase the plant height and number of leaves. Research by Bahrudin et al. [11] found results that the dose of 20 t/ha of bokashi fertilizer and onion residue gave the highest number of leaves at the age of 50 DAP compared to other doses. Meanwhile, Salami and Omotoso found that the highest effect of cow manure at a dose of 20 t/ha on shallot plant height was obtained until the age of 8 weeks after planting, but it was not significantly different from giving 10 t/ha of cow manure [23]. The highest number of shallots was obtained at the age of 7 weeks after planting, and decreased at the age of 8 weeks after planting, but was not significantly different from the application of cow manure 10 t/ha. Similar results were also reported by Gudugi [24]that the application of 20 t/ha cow manure gave a better performance in okra in terms of growth parameters and yield. This result was obtained because the availability of nitrogen in manure promoted vegetative growth during plant development, and helps maintain functional leaf area during the vegetative phase[25].

3.2. Yield components

The yield components were the number of tillers per bulb and bulbs diameter. The results showed that the manure dose significantly affected the number of tillers per bulb and the diameter of the shallot bubs of the seeds (Table 2). It can be seen that, due to the supply of manure, the addition of the number of bulbs per clump ranges from 0.0-50.0 percent. The highest number of bulbs per clump was found when manure was administered at a dose of 25 t/ha (3 bulbs) which was significantly different from manure given at a dose of 0 t/ha (2 bulbs) and a dose of 5 t/ha (2 bulbs). As the opinion of Shimeles that shallot grown from seeds contain an average of 1-3 bulbs per plant[2]. The addition of bulbs diameter due to manure supply ranged from 14.69 to 71.56 percent. The largest bulbs diameter was obtained when manure was administered at a dose of 25 t/ha (3.62 cm) which was significantly different from manure administered at a dose of 0 t/ha (2.11 cm) and a dose of 5 t/ha (2.42 cm). The correlation analysis results showed that the higher the dose of manure given, the higher the number of tillers per bulb and the larger the diameter of the bulbs, with the correlation coefficient (r) respectively r = 0.97 and r = 0.87.

Table 2. Effect of manure dose on the number of bulbs per clump and bulbs diameter of shallot plants from seed. Sukarami Experimental Station, Planting Season, 2019.

Treatment Manure (t/ha)	Yield Components	
	Number of Bulbs per Clump	Bulbs Diameter (cm)
0	2.00 b	2.11b
5	2.00 b	2.42b
10	2.50 ab	3.53 a
15	2.50 ab	3.58 a
20	2.75 ab	3.61 a
25	3.00 a	3.62 a

Note. The numbers followed by different letters indicate the significant difference at the 0.05 DMRT level

Table 2 also shows that manure significantly affected the number ofbulbs per clump compared to no manure at a dose of 25 t/ha and bulbs at 10 t/ha. The low number of bulbs per clump obtained at various manure doses in this study was due to the development of plants using shallot seeds. This is similar to the findings of Maisura et al. [26]that the number of bulbs per clump of shallot plants from bulbs was higher in plots treated with cow manure at a dose of 25 t/ha, but different from the largest diameter bulbs obtained at a dose of 15 t/ha. cow fertilizer compared to 20 t/ha.

3.3. Wet biomass and dry bulbs weight

The results showed that manure's dose had a significant impact on the weight of wet biomass and dry bulbs (Table 3). The addition of wet bulb weight due to manure supply ranged from 31.46 to 156.59 percent. The highest wet biomass weight was observed when manure was administered at a dose of 25 t/ha (21,900 kg/ha). It differed significantly from manure administered at a dose of 0 t/ha (8,535 kg/ha), a dose of 5 t/ha (11,220 kg/ha) and a dose of 10 t/ha (12,530 kg/ha). Research by [9] found the highest wet bulbs weight obtained in the treatment of cow manure with a dose of 30 tons/ha with an average of 7.27 grams/bulbs, an increase of 8.9% from the control treatment. The highest wet biomass weight obtained was supported by the maximum plant height, the number of leaves, and the number of bulbs per clump. Meanwhile, dry bulb weight due to manure supply ranged from 52.35 to 308.38 percent. The highest dry bulb weight was found when manure was administered at a dose of 25 t/ha (9,650 kg/ha) that was significantly different from manure administered at a dose of 0 t/ha (2,363 kg/ha) and a dose of 5 t/ha (3,600 kg/ha). Correlation analysis results have shown that the higher the dose of manure given, the higher the wet bulb weight and the higher the dry bulb weight. The correlation coefficient (r) respectively r = 0.99 and r = 0.98.The same results were obtained in the study of Atmaja et al. (2019), which received the highest dry bulb weight at a dose of 30 tons/ha of cow manure with an average yield of 1.65 grams/bulbs, an increase of 16.1% from the treatment without manure.

Table 3. Effect of manure dose on wet biomass and dry bulbs of shallots plants from seed, Sukarami Experimental Station, Planting Season, 2019

Treatment Manure (t/ha)	Weight		Shrink Bulbs (%)
	Wet Biomass (kg/ha)	Dry Bulbs (kg/ha)	
0	8,535 d	2,363 b	72.31 a
5	11,220 cd	3,600 b	67.91 a
10	12,530 bcd	5,800 ab	53.71 a
15	16,174 abc	5,900 ab	63.52 a
20	18,300 ab	8,538 a	53.34 a
25	21,900 a	9,650 a	55.93 a

Note. The numbers followed by different letters indicate the significant difference at the 0.05 DMRT level

Table 3 also shows that manure has a significant effect on the weight of wet bulbs at a dose of 15 t/ha, while on the importance of dry bulbs at 20 t/ha. On bulb-based shallots, research by Lasmini et al. [22] combining mulches and manure obtained results that the highest plant growth and shallot yield was obtained in the treatment of straw mulch and cow manure with a dose of 5 tons/ha (10,220 kg/ha) compared to the product of shallots with fertilization of compost 5 tons/ha. These results indicate that the application of manure to shallot plants is better than the application of compost. The increase in bulb weight in this study was due to the administration of cow manure, which could significantly increase the growth component (plant height and number of leaves per clumps), yield component (number of tillers per bulb and bulb diameter), and bulb weight, and tended to decrease bulbs. The increase in growth parameters can be influenced by N and P in cow manure, which encourages plant organs' growth to increase the number and size of plant cells[27]. Abdissa et al. [28]also reported that N plays a role in the formation of amino acids, proteins, nucleic acids, enzymes, nucleoproteins, and alkaloids needed in the process of plant growth, especially the development of leaves and plant saplings. P elements also play a role in stimulating root growth and a primary component in formingspecific proteins to accelerate bulb formation. Correlation analysis (Table 4) shows a real positive correlation between the dose of manure and all variables observed, except bulb shrinkage, which shows a tendency to negative correlation (r = -0.77). In the meantime, the regression analysis showed a significant increase in wet bulbs weight and dry bulb weight with the addition of a dose of manure. The regression equation for the wet pipe weight is Y = 8.225.9 + 524.1 X**, r = 0.99. By adding up to 1,000 kg/ha of manure, the weight of wet bulbs may be increased by 524.1 kg/ha. In the meantime, the regression equation for dry bulbweight is Y = 2,307.4 + 293.4 X**, r = 0.98. By adding a dose of manure of up to 1,000 kg/ha, the weight of dry bulbs can be increased by 293.4 kg/ha.

Tabel 4. Correlation matrix of the components of growth, yield components, and bulbs weight of shallot plants from seeds in the treatment of various doses of manure. Sukarami Experimental Station, Planting Season. 2019

Variables	Manure	Plant height	Number of leaves per clump	Number of tiller per bulb	Bulb diameter	Shrink bulbs	Wet biomas s weight	Dry bulbs weight
Manure	1.00							
Plant height	0.95	1.00						
Number of leaves per clump	0.95	0.90	1.00					
Number of tiller per bulb	0.97	0.88	0.97	1.00				
Bulb diameter	0.87	0.87	0.97	0.89	1.00			

Shrink bulbs	-0.77	-0.76	-0.88	-0.84	-0.88	1.00		
Wet biomass weight	0.99	0.93	0.92	0.94	0.81	-0.70	1.00	
Dry bulbs weight	0.98	0.93	0.95	0.98	0.86	0.84	0.97	1.00

Note. r-table=0,81

3.4. Economic of shallot

Manure is used because it is easily obtained from farmers with the price is relatively cheap. Researchers tried to see in terms of the economic value of the use of manure to increase shallot yield. According to the findings of this study, the highest total cost of shallot yield was obtained for the use of manure at 25 t/ha, namely IDR 120,855,000, and the lowest for the use of manure at 0 t/ha, namely IDR 92,255,000 (Table 5).

Table 5. Economic analysis of shallots from seed at several doses of manure. Sukarami Experimental Station, Planting Season, 2019.

Items	Manure Doses (t/ha)					
	0	5	10	15	20	25
Total cost (IDR)	92,255,000	96,505,000	103,205,000	108,505,000	114,505,000	120,885,000
Yield (kg)	2,363	3,600	5,800	5,900	8,538	9,650
Total revenue (IDR)	46,078,500	70,200,000	113,100,000	115,050,000	166,491,000	188,175,000
Net profit (IDR)	-46,176,500	-26,305,000	9,895,000	6,545,000	51,986,000	67,290,000
RCR	0.50	0.73	1.10	1.06	1.45	1.56

The farmers were using more manure (25 t/ha), they are getting high yield (9,650 t/ha). The price received per kgwas IDR 19,500, so farmers who use more manure will get higher profits than farmers who use less manure. According to the findings of this study, farmers who used manure at 0 - 5 t/ha do not get returns because the results obtained are not sufficient for production costs. The revenue cost ratio of shallot from seed production at various of manure was estimated as 0.50, 0.73, 1.10, 1.06, 1.45, and 1.56 respectively. In contrast to the findings of [29, 30] found that onion farming using TSS had higher RCR values, namely 2.0, and 3.15. These results indicate that horticulture farming, especially shallots farming, has a higher risk compared to cultivating other commodities. The size of the RCR of this commodity will become a crucial consideration for farmers to develop shallot cultivation from seeds (TSS) with a choice of manure doses technology.

4. Conclusions

Considering the use of true shallot seed to develop shallot crops among farmers, this study was conducted to estimate shallot yield using manure and economic benefits. The highest yield of 9,650 t/ha was obtained when using manure at 25 t/ha. Adding up to 1,000 kg/ha of manure can increase the weight of wet bulbs by 524.1 kg/ha and the weight of dry bulbs by 293.4 kg/ha. Cultivation of shallots using seeds is profitable when using manure for more than 5t/ha, identified by RCR> 1. The results of this study suggest increasing the yield of shallot bulbs from seeds using cow manure by as much as 10-25 t/ha. Facilitation of shallot seeds (TSS) from the Government is needed so that farmers have easy access to seeds to develop shallot farming in the future.

Data Availability

The authors state that all data generated or analyzed duringthis study are included in this article. The full data used tosupport the findings of this study are available from the corresponding author upon request.==> delete

Conflicts of Interest

The authors declare that there are no conflicts of interest regarding the publication of this paper.

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